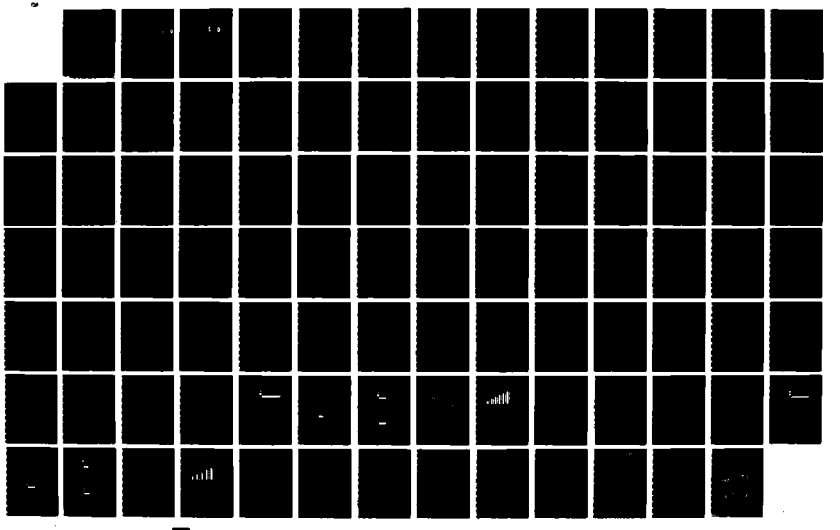
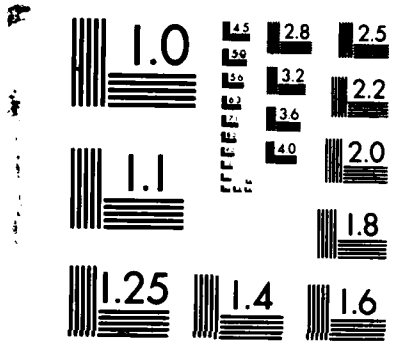
AD-A174 372 AN INVESTIGATION INTO THE EFFECT OF THE MODE OF PRESENTATION ON CONTRACT (U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST D K GRIGWARE

UNCLASSIFIED SEP 86 AFIT/GSM/LSY/86S-8 F/G 5/2 NL

1/1





AN INVESTIGATION INTO THE EFFECT OF THE MODE OF PRESENTATION ON CONTRACT EVALUATION WHEN COST/SCHEDULE CONTROL SYSTEM CRITERIA IS USED

THESIS

Denise K. Grigware
Captain, USAF

AFIT/GSM/LSY/86S-8

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

(2)

AFIT/GSM/LSY/86

AN INVESTIGATION INTO THE EFFECT OF THE MODE OF PRESENTATION ON CONTRACT EVALUATION WHEN COST/SCHEDULE CONTROL SYSTEM CRITERIA IS USED

THESIS

Denise K. Grigware
Captain, USAF

AFIT/GSM/LSY/86S-8

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information is contained therein. Furthermore, the views expressed in the document are those of the author and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the United States Air Force, or the Department of Defense.

AFIT/GSM/LSY/86S-8

AN INVESTIGATION INTO THE EFFECT OF THE MODE OF PRESENTATION ON CONTRACT EVALUATION WHEN COST/SCHEDULE CONTROL SYSTEM CRITERIA IS USED

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Systems Management

Denise K. Grigware
Captain, USAF

September 1986

Acknowledgments

I wish to express my deepest appreciation and gratitude to Lt Shannon W. Switts, because without him this thesis would never have been completed. His constructive criticism and recommendations provided that little extra guidance that I needed to complete the thesis. Even more important was that he was always there to pull me through the rough times, and make me laugh when I thought everything was falling apart. I would also like to thank all the individuals who participated in the research, and everyone else who gave me guidance, because without their support and cooperation this research would not have been possible.

Denise K. Grigware

Table of Contents

List of Figures

List of Tables

Abstract

This research focused on which mode of presentation, tabular or graphical would be more effective in aiding a program manager in his evaluation of a contractor's performance when cost/schedule control systems criteria is used. Effectiveness was measured in terms of decision quality, speed, confidence, and difficulty. A review of the literature in this area identified several important variables that might effect an individual's performance when a particular mode of presentation is used. These variables include the task to be accomplished, field independence/dependence, and experience.

Two test scenarios were designed to test the individual's ability to detect trends, come up with precise numbers, and evaluate a contractor's performance using graphical or tabular information. The scenarios were administered to individuals who are or will be involved in the acquisition process. Along with the test scenarios, the Group Embedded Figures Test was administered to the subjects to determine if the individual was field independent or dependent. A questionnaire was also developed to collect background information on the sample population.

A statistical analysis of the data collected indicated that the task to be accomplished had a large effect on which mode of presentation was most effective. Tabular information was best when accuracy was desired, and graphical data was best when trends needed to be analyzed.

AN INVESTIGATION INTO THE EFFECT OF THE MODE OF PRESENTATION ON CONTRACT EVALUATION WHEN COST/SCHEDULE CONTROL SYSTEM CRITERIA IS USED

I. Introduction

Background

Information is a powerful and important business asset which influences the health and wealth of a corporation (5:29). Since the invention of the computer, businesses have been trying to find new and better ways to use computers to aid in the processing of information. Computer based information systems are designed to collect, store, retrieve, process, and present information (12:309). Information systems can be defined as "planned and organized approaches to supplying executives with intelligence aids that facilitate the managerial process" (10:21). Information systems sort and assemble raw data in order to create the desired information. The key is that the information must be in a form that is useful to management. In short, the manager needs to be able to find the information necessary to make decisions, spot problem areas, and perform other managerial tasks. Therefore, one of the major decisions facing an information system designer is what mode of presentation is the best one for displaying the information. Mode of presentation refers to the way information is presented to the user. The mode of presentation needs to correspond to the type of decision being made, and the needs of the user. The data must be presented in an understandable format that allows managers to easily find the information they need to accomplish their task without having to "hunt" for information.

In the past, the most popular form of information presentation has been tabular data. However, recently, information system designers have become more interested in graphics as a mode of presentation. Decreased hardware costs, the availability of easy-to-use software, and the availability of graphics technology for office workstations have all contributed to this increased interest (6:43). Improvements in hardware have made it possible to view graphs in color as well as black and white. Software enhancements allow managers to highlight parts of the graph for emphasis (13:10). Graphics, are not new; however, the computer technology now exists that enables them to be produced faster, cheaper, and by the end user (9:16). Proponents of computer graphics claim that they will increase managerial productivity in the areas of information recall, decision speed and quality (9:15). However, the research in this area does not fully support these claims. The research that has been done has produced mixed results. Some studies favored graphics, while others favored tables. More research needs to be done in order to achieve some conclusive results. The fundamental issue that needs to be researched is the ability of managers to accurately interpret the information presented graphically and make quality decisions based on that information (6:464).

When choosing a mode of presentation, an information systems designer should ask the following questions:

1. What are the needs of the user?
2. What is the user's background?
3. What is the task to be accomplished?
4. Which mode of presentation will facilitate the user's understanding?

The data should be presented in such a way that managers can understand it, find the information needed to make decisions, spot problem areas, and formulate and evaluate alternative courses of action. In general, information should be displayed in a way that facilitates managerial activities.

Research Problem

In order to choose the correct mode of presentation to use, the information system designer needs to determine the best way to display the information. Research needs to be done to determine when to use tabular information and when to use graphical information. Graphics may help managers make better decisions in some situations, while tabular information will be better in others. The past research suggests that the situation is a determining factor when choosing what mode of presentation to use (3:67,6:475). For instance, graphics appear to better at detecting trends and making comparisons. Whereas, tabular data is best when the user needs precise numbers, because tabular data has been shown to lead to better accuracy (3:67). This study examined which mode of presentation, tabular or graphical, is best suited to aid program managers in evaluating a contractor's performance. This situation requires a program manager to detect trends and compare numbers to accurately assess the contractor's performance. This situation was picked because several program managers, working at the Aeronautical System's Division at Wright Patterson A.F.B. did not like the way the information was being presented to them from the contractor. The cost data was coming in lists, and program managers were having a difficult time determining whether the contractor was over or under cost, and ahead or behind schedule. Terms are defined below.

Research Question. When using cost/schedule control system criteria (C/SCSC) to evaluate a contractor's performance, which mode of presentation, tabular or graphical, will be more effective in aiding program managers in terms of decision quality, speed, confidence, and difficulty? Will graphical or tabular information lead to a better understanding of the situation?

Scope and Limitations

This study compared the effectiveness of tabular and graphical information presentation in aiding a program manager in his evaluation of a contractor's performance. The test subjects were given information pertaining to a contract. The information was displayed in a type written report either graphically or in tabular form. They were then asked to evaluate the performance of the contractor based on the information supplied. By choosing this situation, the population will be limited to those individuals who have some knowledge of C/SCSC.

There are several dependent and independent variables which can be studied concerning information presentation methods. Based on past research the following appear to be the most important. For this reason they were examined by this study:

Dependent Variables - decision quality and speed, user confidence, and decision difficulty;

Independent Variables - field dependence/independence, user background, and mode of presentation.

Definition of Terms

Following are the definitions of the key terms used in this report:

1. Field dependence/independence: "a cognitive style which reflects

whether an individual is bound by external referents or can make use of internal referents in structuring cognitions," (17:967).

2. Decision quality: decision quality for this report was measured by how accurately an individual interpreted the contractor's performance.

3. Decision speed: how much time it takes an individual to evaluate the contractor's performance.

4. Demographics: background information about an individual, such as age, sex, job experience, etc.

5. Cost/Schedule Control System Criteria: a set of standards that a contractors management system must meet when developing a major defense system for the Department of Defense (1:262).

6. Mode of presentation: the way information is portrayed in a report. In this report it refers to either graphs or tables.

7. Effectiveness: For this report the effectiveness will measured in terms of how well the mode of presentation aided the individual in evaluating the contractor's performance in terms of decision quality and speed.

II. Literature Review

The goal of information systems designers is to produce a system that will aid managers in making decisions, spotting problems, evaluating alternative courses of action, and accomplishing other managerial tasks (4:1348). Recently, designers have been paying attention to the mode of data presentation. Is one form of information presentation easier to understand? Can information be presented in such a way that it will help managers make better decisions? Spot problem areas quickly? Declining hardware costs, easy-to-use software, and the availability of graphic technology for office work stations have increased the interest of designers in computer generated graphics as a mode of information presentation (6:463). Proponents of computer graphics claim the following:

1. Graphics lead to more effective analysis and decision making.
2. Graphics help managers spot problems.
3. Graphics make tasks easier.
4. Graphics are more convincing in presentations.
5. A picture is worth a thousand words (15:1).

They feel graphical representation of data, originally presented in tables, may allow managers to compare data values, observe patterns, and detect trends more easily (6:464). However, research does not support their claims. Graphs have been found superior to tables is some situations but not in others. More research is needed before these claims can be considered fact or fiction (15:3-4). Past studies comparing graphical and tabular information

have concentrated in two areas: graphs versus tables and individual differences which influence a manager's ability to use computer graphics.

Graphical vs Tabular Information

The features most studied by researchers have been interpretation accuracy, problem comprehension, and task performance (6:468). Because the traditional method of display is tables, these studies have compared graphical to tabular information. They are interested in finding out the advantages and disadvantages of graphs versus tables. The studies were interested in determining how graphs affected decision quality, speed, user confidence, and the amount of difficulty the user had in making the decision. The past studies seem to indicate that the task to be accomplished has an effect on the mode of presentation that should be used (1:1349,3:475).

Decision Quality, Speed, Confidence and Difficulty. The results of the prior investigations have been inconclusive. In their study, Benbasat and Dexter found no difference between tabular and graphical reports in terms of the quality of decision made. In her research, DeSanctis found seven studies that favored graphs, twelve that favored tables, and ten that showed no difference between the two in terms of accuracy, preference, problem comprehension, and decision quality (6:470). No studies have shown that graphics lead to better confidence or a lower degree of difficulty in decision making, or better recall of the information presented (6:475).

The research also suggests that a combination of the two modes might produce the best results. Benbaset and Dexter conducted a study in which they evaluated the following forms of information presentation:

1. Tabular

2. Graphical

3. Combined tabular-graphical (3:59)

Their findings showed that the combined group significantly outperformed the graphical group in terms of decision quality. The combined group also did better than the tabular group but it was not a significant difference. In terms of decision speed, the tabular group took more time than both the graphical and combined group (3:70-74). These results seem to show that graphs can lead to a faster decision, while tabular data will lead to a more accurate decision. Their study also suggests that the issue may not be to replace tabular data with graphical data, but use the two together to improve decision quality and speed.

Task. The past research has been inconclusive for computer graphics as a decision aid. The fact that some research has shown graphics to be better than tables indicates that in some cases there may be an advantage for graphics. The problem is to identify those conditions in which graphs outperform tables as a mode of presentation (6:475). Zmud, Blocher, and Moffie showed through their research that decision making with tabular and graphic reports varied with task complexity. Graphics were best when the complexity was low, and tables were best when complexity was high (6:475). Benbasat and Dexter feel that graphical and tabular reports need to be evaluated in a variety of settings to identify areas where one has a comparable advantage over the other (4:1349). Ghani feels that performance on a task is contingent on the fit between the task characteristics and the mode of information presentation. The two need to reinforce each other. He has found that tabular representation is best when specific data values are required, and that graphical representation is best

when relationships between data values need to be examined (3:67, 15:4). Dickson, DeSanctis, and McBride conducted a study where they compared graphical and tabular reports in a number of different situations (8:41). From their study, they came up with the following recommendations:

1. Tabular information is best when the task calls for accurate interpretation of data value.

2. Graphical representation is a good choice when the user needs to see a time dependent pattern in a large amount of data. In other words, graphs are good for detecting trends in a large amount of data.

3. Either graphs are tables may be used when presenting small amounts of information to an audience.

4. Graphs are better when presenting an audience with a large amount of information with the purpose of having them recall some facts about the information that was presented (8:46).

The studies mentioned above indicate that the type of task being performed should be considered when choosing a presentation format.

Other Features. DeSanctis has identified graph features which could enhance a manager's ability to use graphs as decision support aids. These features include: color, realism, and simplicity (6:470). Studies have shown that color graphics are preferred over achromatic ones, and that the attention level of the user is raised when color is present. However, these studies have not shown color to improve task performance or graph comprehension (6:471). Realism has been shown to raise the attention level and increase the retention rate among users. But the studies do no show that realism aids comprehension. In fact, the research suggests realistic visuals may detract the user from identifying relevant pieces of information

(6:471). Studies have also shown task performance increases as the simplicity of the graphs increase. The simpler the graph, the easier it is to understand. None of these factors (color, realism, and simplicity) have been examined to see if they have an effect on decision quality and speed (6:471).

Individual Differences

Another area where research has been done is in the field of individual differences. Individual differences refer to how an individual processes information (17:966). Research in this area studies how individual differences may cause one individual to be able to use graphics more easily than another because of the way their brain processes the information that is presented to them (17:966). The individual differences can be broken into three classes: cognitive style, personality and demographics/situational (17:967).

Cognitive Style. Cognitive style has to do with the characteristics of perceptual and thinking behavior in an individual. The most frequent cognitive style studied in graphic research has been field dependence/independence. Field dependence/independence is defined as follows:

> "In a field dependent mode of perceiving, perception is dominated by the overall organization of the field; there is relative inability to perceive parts of a field as discrete. This global quality is indicative of limited differentiation. Conversely, a field independent style of perceiving, in which parts of a field are experienced as discrete from organized background, rather than fused with it, is a relatively differentiated way of functioning" (2:447).

Field independent individuals are said to be more analytical than field

dependent ones. Several studies have shown that field independent individuals are better able to extract information from a graph than field dependent individuals (11:795,17:969). Field dependents find it difficult to take apart a complex figure; therefore, they prefer disaggregated data. Field independents performed equally well with disaggregated data and aggregated data (2:447).

Other cognitive styles that might affect an individual's ability to interpret computer graphics are simple/complex and systematic/heuristic. Simple/complex pertains to structural characteristics of thinking and perception. It has three distinct properties:

1. Differentiation-the number of elements sought and assimilated in cognition;

2. Discrimination-the assigning of slightly varying stimuli to the same or different categories;

3. Integration-the number and completeness of rules used in cognition (17:967).

Systematic/heuristic shows whether or not an individual uses abstract models and systematic processes in cognition, or relies on common sense, experience, and the practicalities of the situation (17:967).

Personality. Personality refers to the cognitive and affective structures maintained by individuals to make adjustments to events, people and situations. Ambiguity, tolerance, extroversion/introversion, and anxiety level are types of personality variables (17:967). Currently, no conclusive results are available relating personality to the user's ability to use one mode of presentation over another.

Demographics. Demographic/situational variables cover a wide range of

personal characteristics. Variables in this area include such things as age, sex. experience, education, intellectual ability, etc. An important situational variable is the amount of stress the decision maker is under. Studies have shown that stress effects the decision maker's ability to obtain and process information (14:643).

A demographic variable that has been studied is experience. Instead of trying to tie confidence to the mode of presentation used, the past research has found that it is related to the amount of experience an individual has in the situation under study (18:190). Experience is directly related to the amount of confidence an individual has in the decision made. In addition to confidence, experience is has also been found to be related to the perceived amount of difficulty the individual had in making the decision. Experience is inversely related to the the amount of difficulty the individual has in making the decision (17:970).

Some studies have shown that individuals with training in computer graphics are better able get information from them (6:472). DeSanctis and Jarvenpaa found that initially graphical representation provided no advantage over tabular form. However, after being repeatedly exposed to graphical representation, a significant difference was found in the performance of individuals using graphical information over those using tabular information when making financial forecasts (7:140). This suggests that a learning process needs to take place before a manager is able to use graphs effectively.

Some researchers feel that graphical information is processed in the right side of the brain. They feel this way because the right side is responsible for imagination, receptivity, and is more concrete in its processing than the left

side. If this theory is correct, people with strong right-brain dominance should be able to use graphics better than those with left-brain dominance (6:479).

Future Research

Although research has been done, the usefulness of graphics to a decision maker is still unknown. The past research is inconclusive, and has produced mixed results. It has, however, identified several important variables for future research. The success of an information system is measured in terms of its effectiveness in managerial decision making. Two important aspects of decision making are the quality of the decision and the amount of time required to make the decision. Therefore, these are two important dependent variables for future research. Other dependent variables that are important are: interpretation accuracy, problem comprehension, task performance, speed of comprehension, memory for information, and viewer preference (6:467-468). Some of the independent variables that need to be looked at are: graph characteristics, user demographics, decision content, and cognitive aspects (6:480).

One of the more important independent variables identified by past research is that of field dependence/independence. Tests have shown that field independents outperform field dependents when a graphical representation of information is used (11:795,17:969). Because of these past results, it is important when testing the mode of presentation to determine whether the individual is field dependent or independent.

Other independent variables that need to be looked at when comparing mode of presentation include the user's background. A person's experience

or knowledge in the field under study will be a factor when determining how much confidence he has in the decision he has made. It will also be a contributing factor in determining the amount of difficulty he had in making the decision. Also, learning seems to be a factor when using graphics as a mode of presentation (7:140). The more a person is exposed to graphics the easier it is for him to use them, and to obtain information from them (7:140). Therefore, it is important to know if the subject has been exposed to graphics as a mode of information presentation.

Another aspect to look at is the task to be accomplished. There is a wide variety of managerial tasks. Graphics may be best suited for some, and tabular data for others. Therefore, research needs to be done that compares graphical information to tabular information in a wide variety of situations. Past research has shown that graphics are best when the user is asked to *detect trends* or compare data, and tabular is best when precise data values are required (3:67).

Through her studies, DeSanctis developed a framework for future research in the use of computer graphics as decision aids (see figure 1) (6:480). The viability of the framework is supported by past research on computer graphics. The framework shows that graph features, user characteristics, and the decision content need to be considered when evaluating the usefulness of computer graphics as decision support aids. In the area of graph features, the information system designer has to design graphs which can be easily interpreted and facilitate quality decision making. Past research has shown that the user characteristics of graphical experience and task knowledge are important variables (6:481). The framework shows how the variables relate to each other.

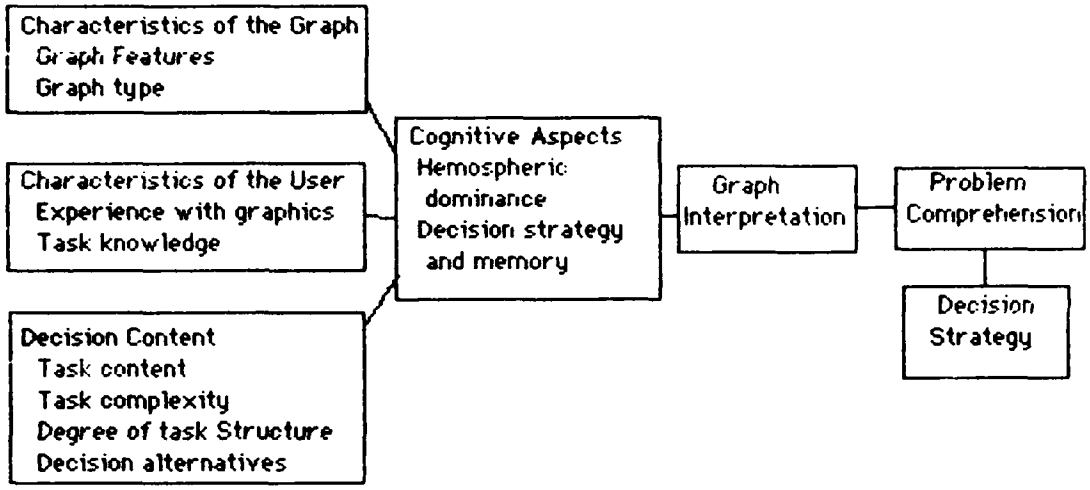


Figure 1. Framework for Research on Computer Graphics (6:480)

Computer graphics are becoming more widely used in management information systems. Proponents claim graphical display of information will improve decision speed and quality (9:15). But the initial research done does not support the claim. The studies that have been done have had mixed results. Some studies favored graphs, others favored data in a tabular form, while others showed no difference between the two. Future research needs to be done to determine where graphical information is better than tabular and vice-versa. The past research has indicated the areas where future research needs to be done, before researchers can answer the question of which mode of information presentation is best for a given situation. Past research has also identified several variables that have an effect on the manager's ability to use graphics. The fundamental issue concerning researchers is: Whether managers will be able to interpret accurately the information presented graphically and make quality decisions based on that information (6:464)?

III. Research Hypotheses

The hypotheses that were used in this study can be broken up into three types, those based on effectiveness measures of an information system, task to be accomplished, and individual differences. Based on the past research, these areas appear to be the most important aspects to consider when comparing the mode of presentation.

Effectiveness Hypotheses

The success of an information system is measured in terms of its effectiveness in the managerial decision making process. Decision speed and quality are two ways to measure the effectiveness of an information system (6:481). For this reason the following hypotheses were tested by this study:

H1: Individuals using graphical information will take the same amount of time to evaluate the contractor's performance as the individuals using tabular information.

H2: Individuals using graphical information will perform as well as individuals using tabular information in terms of questions answered correctly.

These studies have also concluded that the mode of presentation has no effect on the amount of confidence the individual has in the decisions he made, or on how much difficulty the individual had in making that decisions. The following hypothesis were tested to validate the above conclusions:

H3: The amount of confidence an individual has in the decision that was made will not be related to the mode of presentation.

H4: The degree of difficulty an individual had in making the decision will not be related to the mode of presentation used.

Task Dependent Hypotheses

The past research has been inconclusive in determining which mode of presentation leads to better decision making. Several studies have favored graphs, while others have favored tables (4:1349,3:67,6:475). The research has indicated that the situation is a determining factor when choosing a mode of presentation. Tabular information is best for accuracy and graphical information is best for detecting trends. In order to test the above situations, the following two hypotheses were formed:

H5: When asked for precise numbers, individuals with tabular data will outperform, in terms of accuracy, those individuals with graphical data.

H6: When asked to detect trends, or to compare values, individuals with graphical data will outperform, in terms of accuracy, individuals with tabular data.

Individual Differences Hypotheses

The past research has shown that an individual's cognitive style plays an important role in an individuals ability to use graphical information. Previous studies have shown that field independent individuals will outperform field dependent ones when graphical information is used (2:447,11:795,17:969). In addition, field dependents make better decisions using tabular information than they do with graphical information (11:795,17:969). For these reasons the following hypotheses were tested in this study:

H7: Field independent individuals will score higher, in both decision

quality and speed, than field dependent individuals when graphics are used.

H8: Field dependent individuals will score higher, in both decision quality and speed, using tabular data than they will using graphical data.

Another individual difference that is important is experience. Past studies have shown that the amount of confidence placed in a decision is positively related to the number of years of experience possessed by an individual in the situation being tested (18:190). That is, the more experience an individual has in a situation, the more confident he is about the decision he made. Also, the years of experience are inversely related to the individuals perceived level of difficulty (18:190). That is, an inexperienced individual will perceive the task as being more difficult than someone with several years of experience. For these reasons the following two hypotheses were tested in this study:

H9: The degree of confidence an individual has in the decision made will be positively related to years of experience.

H10: The perceived difficulty will be inversely related to years of experience.

IV. Methodology

The methods used to test the research hypotheses were experimentation and survey. Two test scenarios were given to each member of the population. One of the scenario contained the information in tabular form and the other in graphical form. The individual was asked to answer questions based on the information given. After completing the scenarios, the individual was asked to rate each of the presentation modes on understandability, accuracy, usefulness, and satisfaction using 7 point Likert scales. Each individual was also given a survey to collect background information (demographics). Also, the Group Embedded Figures Test was given to each individual to determine if he was field independent or dependent. The level of data obtained by these methods was ordinal and nominal.

Task

The past research has indicated that the task to be accomplished is an important variable when comparing graphical and tabular information. The task for this study was to evaluate a contractor's performance using C/SCSC. The individuals who took the test were asked to determine if the contractor was behind or ahead of schedule, if he was over or under cost, if there was any relationship between the cost and schedule variance, and other questions pertaining to the contractor's performance. The test contained questions that asked the individuals to detect trends, and questions that required data accuracy.

Population

Because of the nature of the test, the individuals in the sample population had to have some knowledge of C/SCSC. For this reason the following individuals were included in the population:

1. Professional continuing education students attending the Systems 200 program management course at the Air Force Institute of Technology.

2. Air Force Institute Technology graduate students in the systems management option (GSM).

3. Program control personnel assigned to the Aeronautical Systems Division (ASD) at Wright Patterson A.F.B.

These individuals represented a cross-section of program managers and cost analysts in the Air Force. However, the sample as not random because every member of the population did not have a non-zero chance of being chosen. This is because some program managers had already completed the Systems 200 course, and some were not yet qualified to take it, some had already completed their masters degree, and others have not yet attended, and some are assigned to other organizations at other Air Force Bases. However, the way the individuals were placed into the two groups was random.

Procedure

The following steps must be completed to test the research hypotheses:

1. Two test scenarios were designed to test the manager's ability to use graphics and tabular information to evaluate the performance of a contractor. The test included questions that asked the subject to detect trends in the data, and questions that called for precise numbers. Included after each scenario, were two Likert scales to

determine how difficult it was for the individual to make the decision and the degree of confidence the individual had in the decision made.

2. The survey to obtain the demographics was designed and validated.

3. Test times were set up with the individuals as follows:

1. The class schedule for the Systems 200 class was obtained, and a test time was set up with the instructor. The test was given to these students after they had their lesson on C/SCSC.

2. The section leader for the GSM's (class 87s) was contacted and a time was arranged for the GSM's to take the test.

3. Individuals at ASD were called and times were set up to go to their office and administer the test.

4. The Group Embedded Figures Test was administered to determine if the individual was field independent or dependent. The test was administered and scored according to the procedures outlined in the Manual for the Embedded Figures Tests (16:27).

5. The test scenarios were given to each individual. The test scenarios were given to individuals and groups. The group size varied between 1 and 40. The following steps were followed when administering the test.

1. Each individual was given a sheet containing key terms in C/SCSC. They were asked to read the sheet and ask questions on terms they did not understand. This was done to ensure that each individual would understand the terms used in the report.

2. The subjects were randomly divided into two groups, A and B. Both groups were be given two test scenarios. In the first scenario Group A had the information in graphical form and group B had the information in tabular form. The mode of information presentation was switched in the second scenario. Each individual was given a copy of the information and the questions to be answered.

3. After completing both scenarios, each individual was given a questionnaire asking him to compare the two methods of information presentation in terms of accuracy, understandability, usefulness, satisfaction, and preference.

4. In order to obtain the time it takes an individual to complete a section of the test, the individuals were timed using a stop watch.. When an individual finished a test scenario, he was asked to raise his hand, and the time it took him to complete the test was recorded on his test paper.

5. Each individual had a maximum of 20 minutes to complete each scenario.

6. After completing the test scenarios, each individual was given a questionnaire to find out about his/her background. What kind of job experience they have, if they have used graphics before, etc.

7. To test the research hypotheses, the data collected was analyzed using SPSSX multiple regression/correlation, paired t tests, and ANOVA packages. The type of test used depended on the hypothesis being tested.

These parametric tests could be used because the population size is greater than 30, and the central limit theorem can be invoked. The

central limits theorem states that if n is large than the mean of the population approaches a normal distribution and a parametric test may be used.

The test procedure used to test hypothesis one and two is as follows:

$$H_0: \quad \mu_1 = \mu_2$$
$$H_a: \quad \mu_1 \neq \mu_2$$

Where μ is mean of the sample.

To test these hypotheses the oneway analysis of variance command will be used. This test procedure will give us an F value, F_t. The null hypothesis, H_0, will only be rejected if $F_t > F_{0.05}$, or if the probability of $F_t < 0.05$.

The test procedure used to test hypotheses five through eight is as follows:

$$H_0: \quad \mu_1 > \mu_2$$
$$H_a: \quad \mu_1 \leq \mu_2$$

Where μ is mean of the sample.

Again the oneway analysis of variance command will be used to test the hypotheses. For these hypotheses, the null hypotheses was rejected only if $F_t < F_{0.05}$, or the probability of $F_t > 0.05$.

To test hypotheses three and four, the paired t test was used. This statistical test was used because individuals evaluated the contractor using both tabular and graphical information. They rated their difficulty and confidence in their evaluation for both forms of information portrayal. This data is paired because two observations

were obtained from one individual. The test procedure is as follows:

$$H_0: \quad \mu_1 - \mu_2 = 0$$
$$H_a: \quad \mu_1 - \mu_2 \neq 0$$

Where μ is the mean of the sample population.

The paired t test will return a t value, t_t. The null hypothesis was rejected if $t_t > t_{0.05}$, or the probability of $t_t < 0.05$. This same procedure was used to determine if there was any difference in the ratings (usefulness, accuracy, difficulty, and satisfaction) for each report.

Regression analysis was used to test hypotheses nine and ten. These hypotheses are trying to see if there is any relationship between the years of experience and the level of confidence and years of experience and degree of difficulty an individual has. Regression analysis will return two values that are important to look at. The F value, F_t, shows if they is a relationship between the variables. If $F_t > F_{0.05}$, or the probability of $F_t < 0.05$, then there is a relationship between the variables. The other value returned by the regression analysis is R^2, or the coefficient of determination. This value has a range of 0 to 1. A value of 0 indicates that the relationship is not linear. The closer the value is to one, the stronger the linear relationship is between the two variable.

A pearson correlation procedure was done on all the independent and dependent variables examined in the study, to determine if there was any interactions between the variables. The pearson correlation will return an r value. The absolute value of r tells if a linear

relationship exists between two variables. A value of zero means that there is no linear relationship between the variables, while a value of one indicates a strong linear relationship. A negative r value means that the two variables are inversely related to each other, and a positive value means that they are directly related.

All hypotheses used an alpha level, or level of significance, of 0.05.

V. Analysis and Results

The purpose of this study is to determine which mode of presentation, graphs or tables, is more effective in aiding program managers in their evaluation of a contractor's performance when C/SCSC is used. Effectiveness in this study was measured in terms of decision quality, speed, confidence, and difficulty. In order to determine which mode is most effective, the research hypotheses had to be tested and analyzed. This section discusses the analysis of the hypotheses and the results that were obtained.

Population

Seventy-seven individuals, 60 military and 17 civilians, participated in this study. Tables I thru IV provide demographical information on the sample. Table I shows the average age of the individuals, the average number of years worked for the Air Force, and the number of years experience with C/SCSC. The average individual was 30 years old, has been in the Air Force for seven years, and has less than 1 year of C/SCSC experience.

Table II shows that 74% of the population tested was male. Tables III and IV show how the population was distributed among different Air Force Specialty Codes and ranks/grades. Fifty-eight percent of the individuals tested were in the program management career field, and half of the individuals were Lieutenants. The majority of civilians tested were in the 501 career field. The grade spread was from 2Lt to LtCol for the military, and from a GS-7 to a GM-15 for the civilians.

These statistics show that the majority of the individuals tested are

involved in the acquisition process for the Air Force. These individuals will be involved in evaluating contractor's performance, and it is important to determine the best way to present the information to them. These individuals represent the individuals who will be making the decisions on the major weapon systems in the future.

Table I - Age, Years in Air Force, and C/SCSC Experience

	Mean	Standard Deviation	Range
Age	30.312	7.696	22 - 58
Years in Air Force	7.227	7.684	1 - 36
C/SCSC Experience	0.766	2.006	0 - 15

Table II - Gender

	Count	Percentage
Male	57	74.0
Female	20	26.0
Total	77	100.00

Table III - Breakout by Air Force Specialty codes (AFSC)

	AFSC	Frequency	Percent
Military			
	26xx	2	2.6
	27xx	45	58.4
	28xx	4	5.2
	49xx	4	5.2
	67xx	4	5.2
	70xx	1	1.3
Civilian			
	501	14	18.2
	345	3	3.9
	Total	77	100.00

Effectiveness Hypotheses Analysis

HYPOTHESIS ONE: Individuals using graphical information will take the same amount of time to evaluate the contractor's performance as the individuals using tabular information.

The time here refers to the total amount of time it took an individual to complete all three parts, evaluation, accuracy, and trend detection, of the test scenario. The time was recorded in seconds.

Table IV - Breakout by Rank/Grade

	Rank/ Grade	Count	Percent
Military			
	2Lt	16	20.8
	1Lt	23	29.9
	Capt	14	18.2
	Maj	6	7.8
	LtCol	1	1.3
Civilian			
	GS-7	2	2.6
	GS-9	3	3.9
	GS-11	6	7.8
	GS-12	2	2.6
	GS-13	2	2.6
	GS-14	1	1.3
	GM-15	1	1.3
	Total	77	100.00

The oneway analysis of variance command in SPSSX was used to compare the time taken to complete the evaluation with graphical information and the time taken with tabular information. The mean time required by individuals using graphical information was 416 seconds, and the mean for tabular information was slightly less at 401. However, this difference is not significant at the 0.05 level. Therefore, hypothesis one can not be rejected. The results of the analysis are summarized in Tables V and VI.

Table V - Time To Complete Test (Time in seconds)

Mode of Presentation	Mean	Standard Deviation	Count	Min	Max
Tabular	401.4416	132.9685	77	145	790
Graphical	416.1299	122.4317	77	154	691
Total	413.7208	127.6032	154	145	790

Table VI - Oneway Analysis of Variance - Time by Mode of Presentation

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	1	8306.2403	8306.2403	0.5085	0.4769
Within Groups	152	2482929.688	16335.0637		
Total	153	2491235.929			

HYPOTHESIS TWO: Individuals using graphical information will evaluate the contractors performance, in terms of questions answered correctly, as well as individuals using tabular information.

Scores for evaluation were based on the number of questions answered correctly on the evaluation part of the test. Evaluation involves determining whether the contractor is ahead or behind schedule and under or over cost. These are questions 1 through 4 on the tabular test, and questions 1, 2, 8,

and 9 on the graphical test (See Appendix A). The maximum possible score is 8. The oneway analysis of variance command was used again to determine if there is a difference in means.

The analysis showed that individuals using graphical information performed better at evaluating the contractor' s performance. The mean for individuals using graphs was 7.7143, and 7.2857 for individuals using tables. This difference is statistically significant at the the 0.05 level. This result leads leads to the rejection of hypothesis two. These results, in this case, indicate that graphical information was better for determining whether a contractor is ahead or behind schedule, and over or under cost. Tables VII and VIII summarize the results of the analysis.

Table VII - Contract Evaluation Test Scores by Mode of Presentation

Mode of Presentation	Mean	Standard Deviation	Count	Min	Max
Tabular	7.2857	1.7157	77	2	8
Graphical	7.7143	0.6460	77	5	8
Total	7.5000	1.3098	154	2	8

Table VIII - Oneway Analysis of Variance - Contract Evaluation Test Scores by Mode of Presentation

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	1	7.0714	7.0714	4.2081*	0.0419
Within Groups	152	255.4286	1.6805		
Total	153	262.500			

*Significant F value

HYPOTHESIS THREE: The amount of confidence an individual has in the decision that was made will not be related to the mode of presentation.

After completing a test the individual was asked to rate the amount of confidence he had in his evaluation of the contractor. A seven point Likert scale was used to do this. A rating of seven represents the highest degree of confidence, and a rating of one the lowest.

The SPSSX paired t-test was used to determine if the mode of presentation had any effect on the perceived amount of confidence an individual possessed in the decision that was made. The mean amount of confidence displayed for individuals using tables was 5.4935. The mean for graphical information was slightly less at 5.4286. However, this difference is not significant at the 0.05 level. Therefore, the hypothesis can not be rejected. This result supports previous studies in showing that the mode of

presentation has no effect on the amount of confidence possessed by an individual (6:475). Table IX summarizes the results of the analysis.

HYPOTHESIS FOUR: The degree of difficulty an individual had in making a decision will not be related to the mode of presentation used.

Along with rating the confidence they had in their evaluation, individuals were also asked to rate the amount of difficulty they had in evaluating the contractor's performance. A rating of seven in this case, means the individual had a great deal of difficulty, and a rating of one means the individual had no difficulty in his evaluation.

Like hypothesis three, the SPSSX paired t test was used to analyze the results. The analysis showed that individuals using graphical information perceived themselves as having slightly less difficulty, 2.7792, than those using tabular information, 2.9221. This difference is slightly larger than the difference in confidence means, but again it is not significant at the 0.05 level. This means that hypothesis four can not be rejected. These findings again confirm the findings of previous studies that showed that difficulty had nothing to do with the form of information presentation (6:475). A summary of this analysis is found in Table IX.

Table IX - Confidence and Difficulty vs Mode of Presentation (Paired T-test)

	Mean Tables	Mean Graphs	Dif-ference	Standard Deviation Graphs	Standard Deviation Tables	T Value	T Prob
Confidence							
	5.4935	5.4286	0.0649	1.096	1.057	0.59	0.556
Difficulty							
	2.9221	2.7792	0.1492	1.355	1.199	1.17	0.246

N=77 for all cases

Task Dependent Hypotheses Analysis

HYPOTHESIS FIVE: When asked for precise numbers, individuals with tabular information will outperform, in terms of accuracy, individuals with graphical information in terms of accuracy.

To test this hypothesis, five questions, questions 5 through 9 on the tabular test, and questions 3 through 7 on the graphical test (See Appendix A) were on each test asking the individual to come up with specific numbers. The number the individual put down was marked correct if it was within 5% of the actual number (plus or minus). The maximum possible score was 5.

The one way analysis of variance command was used to determine if the mean for the tabular group was higher than the mean for the graphical group. The results showed that the mean for the tabular group, 4.9481, was

significantly higher than that of the graphical group, 3.5325, at the 0.05 level of significance. This means that hypothesis four can not be rejected. These results are consistent with those of studies done in the past (3:70, 8:41). In order do obtain exact values from a graph a certain amount of estimation is involved depending on the scale of the graph. If the accuracy desired is beyond the scales graduations, then the individual is forced to estimate more. The test results further support this rather obvious fact. The results showed that it got even harder to estimate the number as the number got smaller. Individuals were fairly accurate in estimating the number as long as it was greater than one, but had difficulty when it was less than one. This shows that if precise numbers are required, it is best to give the information in tabular form. The results of this analysis can be found in Tables X and XI.

Table X - Accuracy by Mode of Presentation

Mode of Presentation	Mean	Standard Deviation	Count	Min	Max
Tabular	4.9481	0.2761	77	3	5
Graphical	3.5325	0.7179	77	2	5
Total	4.2403	0.8934	154	2	5

Table XI - Oneway Analysis of Variance - Accuracy by Mode of Presentation

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	1	77.1494	77.1494	260.8192*	0.0000
Within Groups	152	44.9610	0.2958		
Total	153	122.1104			

*Significant F value

HYPOTHESIS SIX: When asked to detect trends, or to compare values, individuals with graphical information will outperform, in terms of questions answered correctly, individuals with tabular data in terms of questions answered correctly.

Five questions were included on the tests, questions 10 thru 14 on both exams, asking the individual to detect trends or compare values. This part of the exam was scored by the number of trends detected correctly or the right comparison being made. The maximum possible score was 5.

The same procedure used to test hypothesis five was also used to test hypothesis six. The analysis revealed that information in graphical formed allowed the individual to detect the trends better than information presented in tabular form. The mean for the graphical group was 4.3506, while the mean for the tabular group was 3.9351. The difference in these means is significant at the 0.05 level, and therefore, the hypothesis is not rejected. These findings support the studies in the past that have shown

that graphical information is better for showing trends than tabular information (3:67, 8:41, 15:4). The results of the analysis are summarized in Tables XII and XIII.

Table XII - Trend Detection by Mode of Presentation

Mode of Presentation	Mean	Standard Deviation	Count	Min	Max
Tabular	3.9351	0.8325	77	2	5
Graphical	4.3506	0.8851	77	1	5
Total	4.1429	0.8841	154	1	5

Table XIII - Oneway Analysis of Variance - Trend by Mode of Presentation

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	1	6.6494	6.6494	9.0074*	0.0031
Within Groups	152	112.2078	0.7382		
Total	153	118.8571			

*Significant F value

Individual Difference Hypotheses Analysis

HYPOTHESIS SEVEN: Field independent individual will score higher, in terms of contract evaluation, time, trend detection, and accuracy, than field dependent individuals when graphics are used.

Before this hypothesis can be analyzed, the sample population needs to be broken up into field independent and field dependent individuals. To do this the group embedded figures test was administered and scored according to the procedures in the Manual for the Embedded Figures Tests (16:27). These scores were analyzed and the results are in Table XIV. The mean for the test was 13.81. Based on the test mean, 13.81, individuals who scored 13 or less were classified as field dependent, and those that scored 14 or higher were classified as field independent. This mean is slightly higher than the mean stated in the Manual for the Embedded Figures Tests, 12.0, (16:28). However, it is the same cutoff that Benbaset and Dexter, Lusk, and Docktor and Hamilton used in their studies (4:1353). This cutoff point resulted in 44 individuals being classified as field independent and 33 as field dependent.

Table XIV - Group Embedded Figures Test

Mean:	13.831	Minimum:	4
Standard Deviation:	4.092	Maximum:	18
Field Dependent <=13		Field Independent >=14	

In order to test the hypothesis, four different analysis of variance tests were conducted using the SPSSX oneway command. The first one tested to see if there was any difference in the amount of time it took to complete the test for the two groups. The analysis showed that the mean time for field independent group to complete the test using graphical information was less than the mean time for field dependent group, 402.0455 to 434.9091. However, this difference is not significant at the 0.05 level. Consequently, this result does not support the hypothesis.

The second analysis compared the evaluation scores for both groups. The results again showed that field independents scored higher than field dependents, but this time the difference was significant at the 0.05 level. This result supports hypothesis seven.

The third analysis compared the scores for the accuracy portion of the test. Again, the mean for field independents, 3.6591, was higher than the mean for field dependents, 3.3636. Yet, this difference was not significant at the 0.05 level.

The final analysis was done to compare the scores for trend detection. The findings here showed that field independents did significantly better than the field dependents, 4.5227 to 4.1212. This supports the hypothesis.

The results of this analysis shows that field independents did perform better than field dependents when graphs were used for the mode of presentation. However, the difference was only significant for the evaluation and trend detection parts of the test. This suggests that in some situations field independent and dependents should be able to use graphs without any significant difference in performance. The results of these tests are summarized in Table XV and XVI.

Table XV - Graphical Results by Field Dependent/Independent

	Count	Mean	Standard Deviation	Minimum	Maximum
Time					
Dependent	33	434.9091	127.644	170	660
Independent	44	402.0455	117.8744	154	691
Evaluation					
Dependent	33	7.4848	0.8704	5	8
Independent	44	7.8864	0.3210	7	8
Accuracy					
Dependent	33	3.3636	0.7424	2	5
Independent	44	3.6591	0.6801	2	5
Trend					
Dependent	33	4.1212	1.0535	1	5
Independent	44	4.5227	0.6985	3	5

HYPOTHESIS EIGHT: Field dependent individuals will score higher, in terms of contract evaluation, time, accuracy, detection of trends, using tabular data than they will using graphical data.

The method of analysis for hypothesis eight is the same as hypothesis seven, except the mean comparison is done for field dependents only. The analysis of variance test was done for the four areas, time, contractor evaluation, accuracy, and trend detection. A summary of the results can be found in table XVII and XVIII.

Table XVI - Oneway Analysis of Variance - Graphs by Field Independence/Dependence

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Ratio	F Prob
Time					
Between Groups	1	20366.0649	20366.0649	1.3652	0.2463
Within Groups	75	1118836.636	14917.8218		
Total	76	1139202.701			
Evaluation					
Between Groups	1	3.0400	3.0400	7.9515*	0.0061
Within Groups	75	28.6742	0.3823		
Total	76	31.7143			
Accuracy					
Between Groups	1	1.6461	1.6461	3.2902	0.0737
Within Groups	75	37.5227	0.5003		
Total	76	39.1688			
Trend					
Between Groups	1	3.0400	3.0400	4.0360*	0.0481
Within Groups	75	56.4924	0.7532		
Total	76	59.5325			

*Significant F value

The results of the analysis show that field dependents took less time and did better on the accuracy part of the test when tabular information was used as opposed to graphical information. However, the difference was significant at the 0.05 level only for the accuracy part. On the evaluation and trend detection parts of the test field dependents did better when graphical data was used, but the difference was not significant. From these results, hypothesis eight is only supported when the questions involve accuracy; otherwise it would have to be rejected for the other cases.

Table XVII - Field Dependent Results by Mode of Presentation

	Count	Mean	Standard Deviation	Minimum	Maximum
Time					
Graphical	33	434.9091	127.644	170	660
Tabular	33	413.3636	145.3915	145	659
Evaluation					
Graphical	33	7.4848	0.8704	5	8
Tabular	33	7.2424	1.6589	2	8
Accuracy					
Graphical	33	3.3636	0.7424	2	5
Tabular	33	4.9091	0.3844	3	5
Trend					
Graphical	33	4.1212	1.0535	1	5
Tabular	33	3.8788	0.7809	2	5

Table XVIII - Oneway Analysis of Variance - Mode of presentation by Field Dependence

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Ratio	F Prob
Time					
Between Groups	1	7659.4091	7659.4091	0.4092	0.5246
Within Groups	64	1197816.364	18715.8807		
Total	65	1205475.773			
Evaluation					
Between Groups	1	0.9697	0.9697	0.5526	0.4600
Within Groups	64	112.3030	1.7547		
Total	65	113.2727			
Accuracy					
Between Groups	1	39.4091	39.4091	112.7805*	0.0000
Within Groups	64	22.3636	0.3494		
Total	65	61.7727			
Trend					
Between Groups	1	0.9697	0.9697	1.1278	0.2922
Within Groups	64	55.0303	0.8598		
Total	65	56.0000			

*Significant F value

HYPOTHESIS NINE: The degree of confidence an individual has in the contract evaluation will be positively related to the years of experience.

In order to thoroughly test the hypothesis, two different regression analyses were done. The first one compared total Air Force experience with the amount of confidence, and the second one compared the amount of C/SCSC experience with the level of confidence. Amount of experience was measured by the number of years the individual worked in that area. The first analysis showed that there is an inverse relationship between the amount of Air Force experience and the individual's confidence level at a level of significance of alpha = 0.05. However, the coefficient of determination, r^2, is relatively small, which means there is not a strong linear relationship between the two variables, experience and confidence. Also the value of beta is negative, which indicates an inverse relationship. The second analysis showed that there is no relationship between the number of years of C/SCSC experience and level of confidence. The results of the two regression analyses do not support hypothesis nine. A summary of these analyses can be found in table XIX.

HYPOTHESIS TEN: The individual's perceived level of difficulty will be inversely related to years of experience.

In order to adequately test this hypothesis two regression analyses were also done. This time the analysis involved comparing the years of Air Force experience and the years of C/SCSC experience to the amount of difficulty the individual had in evaluating the contractor's performance. The results of both regression analyses showed that they was no relationship between the amount of difficulty and the number of years of experience either in the Air

Force or C/SCSC. The results of the analysis are summarized in table XX. Consequently, this led to rejection of hypothesis ten.

Table XIX - Confidence - Experience Regression Analysis

	Beta	Standard Error Beta	Constant	T Value	Significance of T
C/SCSC Experience	-0.042890	0.043263	5.493903	-0.991	0.3231
$r^2 = 0.00642$					
Air Force Experience	-0.033553	0.010988	5.703536	-3.051	0.0027
$r^2 = 0.05770$					

The results of the above regression analysis seem to show that there is another factor involved in determining the the level of confidence and the degree of difficulty other than the years of experience. The amount of experience in C/SCSC was probably not a good indicator because most of the individual tested had only been exposed to it for under one month. A pearson correlation was be done to see what other variables effect confidence and difficulty. This correlation analysis included all the dependent and independent variables to see what other relationships may exist.

Table XX - Difficulty - Experience Regression Analysis

	B	Standard Error B	Constant	T Value	Significance of T
C/SCSC Experience	-0.060717	0.051409	2.897173	-1.181	0.2394
r^2 = 0.00909					
Air Force Experience	0.012975	0.013440	2.756872	0.965	0.3358
r^2 = 0.00609					

Pearson Correlation

The pearson correlation analysis outputs a value called r. This value ranges from a -1 to +1. The absolute value of r is the strength of the linear relationship between two variables. A negative value of r tells you that an inverse relationship exists, while a positive value indicates a positive relationship. The pearson correlation analysis was done using the independent variables, such as field independent/dependent and experience, and the dependent variables, such as time, evaluation, accuracy, trend, confidence, and difficulty. The mode of presentation was not included in the analysis because it has already been compared to all of the dependent variables. The results of the analysis are found in table XXI - XXIII.

Table XXI shows the interactions between the dependent variables. The results of the pearson correlation reveals that the amount of time it took an

individual to evaluate the contractor's performance had an effect on his confidence and difficulty. For example, the less time he took, the more confidence he had in his evaluation. Conversely, individuals taking more time had more difficulty and less confidence in their evaluation of the contract. The results indicate that the amount of time an individual took had no effect on how well he did in terms of accuracy, contract evaluation, and trend detection. The results also show that the strongest relationship is between confidence and difficulty, which are inversely related to each other. That is, the more confident an individual is, the less difficult he perceived the task to be. Other variables that have a positive relationship with confidence are the scores on the accuracy and trend portions of the test. As the scores on these portions of the test went up the confidence level increased. The scores on the trend portion also have an inverse relationship with the individual's perceived amount of difficulty.

Table XXI - Interaction Between Variables - Dependent Variables

	Time	Eval	Acc	Trend	Conf	Diff
Time	1.0000	0.0293	-0.0376	-0.0695	-0.3694	0.3888
	(0)	(154)	(154)	(154)	(154)	(154)
	p= .	p= .359	p= .322	p= .196	p= .000	p= .000
Eval		1.000	-.0698	0.1755	0.0488	-0.1387
		(0)	(154)	(154)	(154)	(154)
		p= .	p= .195	p= .015	p= .274	p= .227
Acc			1.000	-0.1269	0.1427	-0.0251
			(0)	(154)	(154)	(154)
			p= .	p= .058	p= .039	p= .275
Trend				1.000	0.1579	-0.1899
				(0)	(154)	(154)
				p= .	p= .025	p= .009
Conf					1.000	-0.5883
					(0)	(154)
					p= .	p = .000
Diff						1.000
						(0)
						p= .

Table XXII shows the interactions between the dependent and independent variables. The variable eft is the scores obtained by the individual on the group embedded figures test. This variable, eft, had an effect on the level of confidence and the amount of difficulty an individual had. Individuals who scored higher on the group embedded figures test had less difficulty and more confidence in their evaluation than those individuals who did not score very high. Another, relationship that can be detected is the one between C/SCSC experience and the amount of time it took an individual to complete the exam. Subjects with more C/SCSC experience tended to take less time to complete their evaluation. This is not surprising because the more familiar an individual is with a task, the less time it should take him to complete it. As noted above in the regression analysis, the number of years of Air Force experience has an inverse relationship with the level of confidence.

Table XIII shows the relationships between the dependent variables. NO results of any real value can be determined here. The only thing noticeable is that the subjects with less experience, both Air Force and C/SCSC, tended to score higher on the group embedded figures test.

Table XXII - Interaction Between Variables - Dependent - Independent

	Time	Eval	Acc	Trend	Conf	Diff
Eft	-0.1051	0.0135	0.0833	0.2176	0.2299	-0.1918
	(154)	(154)	(154)	(154)	(154)	(154)
	p= .097	p= .434	p= .138	.003	p= .002	p= .009
C/SCSC	-0.2036	-0.0522	-0.0232	-0.0697	-0.0802	-0.0954
	(154)	(154)	(154)	(154)	(154)	(154)
	p= .006	p= .260	p= .388	p= .195	p= .162	p= .120
AF Years	-0.0256	-0.0607	-0.0251	-0.1226	-0.2402	0.0781
	(154)	(154)	(154)	(154)	(154)	(154)
	p= .377	p= .227	p= .378	p= .065	p= .001	p= .168

Table XXIII - Interaction Between Variables - Independent Variables

	Eft	C/SCSC	AF Years
Eft	1.0000	-0.1744	-0.1702
	(0)	(154)	(154)
	p= .	p= .014	p= .017
C/SCSC		1.0000	0.3223
		(0)	(154)
		p= .	p= .000
Years			1.0000
			(0)
			p= .

Subject's Ratings of Report Attributes

After completing both test scenarios the subject was asked to rate each mode of presentation on usefulness, accuracy, difficulty, and satisfaction. The results of these ratings are displayed in Table XXIV. For all cases the best rating is a one, and the worst a seven. From the table it can be seen that the individuals thought the graphical information was more useful than tabular. Graphical information was also rated less difficult, and the subjects were more satisfied with it. The only area that tabular information was rated higher than graphical was accuracy. This is not surprising, because it is hard to get a precise number off a graph when the scale is larger than the desired accuracy.

To determine if any of these differences was significant a paired t-test was run using SPSSX. The results of this test is in Table XXV. The test showed that the difference was significant, at the 0.05 level, in the areas of usefulness and accuracy. From this result, it can be concluded that graphs are more useful while tables are more accurate.

Along with rating the report, the subject were also asked which format they preferred, and which one they would prefer if they had to take the test again. Their responses were analyzed and the results showed that 61.0% of the individuals liked the graphical report better than the tabular one. Also, 61% said they would prefer to have the graphical format if they were to take the test again. Table XXVI summarizes all of these results.

Table XXIV - Attribute Ratings

	Mean	Standard Deviation	Min	Max
Usefulness				
Graphical	2.6364	1.555	1	6
Tabular	3.2338	1.661	1	7
Accuracy				
Graphical	4.1818	1.412	2	7
Tabular	1.8961	1.220	1	6
Difficulty				
Graphical	2.6753	1.626	1	6
Tabular	3.1429	1.393	1	6
Satisfaction				
Graphical	2.9351	1.499	1	7
Tabular	3.2208	1.501	1	7

Table XXV - Attribute Ratings vs Mode of Presentation (Paired T-test)

	Mean Difference	Standard Error	Degrees of Freedom	T Value	Prob
Usefulness	-0.5974	0.271	76	-2.20	0.031
Accuracy	2.2857	0.223	76	10.27	0.000
Difficulty	-0.4675	0.240	76	-1.95	0.055
Satisfaction	-0.2857	0.256	76	-1.12	0.268

N=77 for all cases

Table XXVI - Preferences

	Count	Percentage
Liked the Best		
Graphical	47	61.0
Tabular	30	39.0
Total	77	100.00
Prefer if had to take the test again		
Graphical	47	61.0
Tabular	30	39.0
Total	77	100.00

VI. Conclusions and Recommendations

RESEARCH QUESTION: When using cost/schedule control system criteria to evaluate a contractor's performance, which mode of presentation, tabular or graphical, will be more effective in aiding program managers in terms of decision quality, speed, confidence, and difficulty? Will graphical or tabular information lead to a better understanding of the situation?

In order to thoroughly answer this research question each aspect, decision quality, decision speed, confidence, and difficulty, was examined separately. Included in decision quality are the areas of contract evaluation, accuracy, and trend detection.

In the area of decision quality, graphical information led to better performance in the areas of contract evaluation and trend detection, while tabular data was best for accuracy. However, if just field dependent individual's scores were analyzed, no significant difference was found in the areas of contract evaluation and trend detection. The scores, for field dependents, were higher when graphical information was used, but it was not significantly better than the scores when tabular information was used. Determining whether or not the contractor is ahead or behind schedule, and over or under cost is important in this situation, because it will determine how much more analysis in needed. If the contractor is on schedule and cost, no further analysis needs to be done. If he is over cost or behind schedule, the situation needs to be checked into further. Trend detection is needed, because it is important to see if there is an overall trend developing

in the contractor's performance. Is he falling further behind, or is this just a one month slippage? Accuracy will be become more important later when the information is used to estimate the final cost of the project, and the expected completion date. Based on this, it appears that the results of this study indicate that graphical information is more effective in aiding program managers evaluate a contractor's performance when accuracy is not important. If accuracy is important, a combination of graphical and tabular information should be used.

Decision speed was the next area examined. The results of the statistical analysis showed that there was no significance difference in speed between graphical and tabular reports. Therefore, in terms of decision speed either method of information presentation may be used and the results will be the same.

According to the statistical analysis, confidence and difficulty were not related to the mode of presentation that was used. On the contrary, the findings revealed that the perceived level of confidence is inversely related to years of Air Force experience. In addition, the pearson correlation analysis showed that as the scores on the group embedded figures test increased the subject had more confidence in his evaluation, and less difficulty in completing the task, but the mode of presentation had nothing to do with this result.

Individual preference's play an important role when choosing what mode of presentation to use. Information should be presented to a manager in a the form that he will get the most benefit from. Based on the analysis of the ratings given to each report, graphs were found more useful, and tables more accurate. No significant difference was found in the areas of difficulty

and report satisfaction. Sixty-one percent of the individuals test said they would prefer to have the information in graphical form. However, this number could change if accuracy was viewed as the most important factor.

Conclusion

The results of the analysis show that there is no clear cut answer to the research question. The study showed that the mode of presentation had no significant effect on decision speed, confidence, and difficulty. Decision quality was the only effectiveness measure that was affected by the mode of presentation. In terms of decision quality, the results indicate that the task to be accomplished had an effect on which mode was most effective. If accuracy is desired, then tabular information would have to be chosen as the mode of presentation. If trend detection is more important, then graphs would prove to be more effective. Perhaps a better alternative would be to present the program manager with both modes of presentation. This will enable tables to be used when accuracy is needed, and graphs when trend detection is desired.

In conclusion, it can not be determined using these results which mode of presentation is more effective in aiding a program manager evaluate a contractor's performance when C/SCSC is used. The mode of presentation needs to fit the task to be accomplished, and there are several tasks required to evaluate a contractors performance. Instead of choosing one mode for the entire situation, it would be best to look at each task individually and choose the best mode of presentation for that task. Therefore, the best solution would be to use both modes of presentation to evaluate a contractor's performance.

Recommendations

This research only examined one aspect of a program manager's job. Since this research showed that the task to be accomplished was an important factor, each aspect of a program manager's job needs to be looked at separately to determine which mode of presentation, or combination of modes, is best suited for that situation. Other possible areas of study are in planning, programming, and budgeting, manpower requirements, scheduling, trade off analysis (performance vs cost vs schedule), and cost analysis. Additional study may also be done in the area of C/SCSC to determine what combination of modes, tables and graphs, will produce the best results.

Another area to consider is the effect of altering the graph's features.. Perhaps there are better ways to graph the information than the ones used in this study. For example, the use of color graphics may produce better results. Also, the scale of the graphs could also be changed, possibly resulting in better accuracy when the information is portrayed graphically.

Research in these areas are needed because of the increased availability of computer graphics capabilities for office workstations. Proponents of computer graphics are saying that graphics will lead to better decision making, but this has yet to be proven. The cost of these new capabilities need to be warranted before the systems are purchased.

Appendix A: Test Scenarios

Test One: Cover Sheet

The Contractor has supplied you with the following information pertaining to project X. Elements A,B, and C make up the project X. Answer the following questions based on the information supplied. You will have 20 minutes to complete the test.

Key Terms

BCWS - Budgeted Cost Work Scheduled - the amount of work that should have been completed to date and the amount it should have cost.

BCWP - budgeted cost work performed - the amount of work that has been completed to date and the amount that the work should have cost.

ACWP - actual cost work performed - the actual cost of the work that has been completed to date.

BCWP-BCWS = schedule variance

BCWP-ACWP = cost variance

Negative variances implies behind schedule or over cost.

Test One: Tabular

PERFORMANCE DATA FOR MAY
(CUMULATIVE TO DATE)

ELEMENT	BCWS	BCWP	ACWP	SCHEDULE VARIANCE	COST VARIANCE
A	1200	1250	1290	50	(40)
B	2400	1840	2000	(560)	(160)
C	2000	1894	1939	(106)	(45)
TOTAL	5600	4984	5229	(616)	(245)

Using the information above answer questions 1-9.

1. Is the contractor behind or ahead of schedule?

2. Is the contractor over or under cost?

3. What elements are over cost?
   under cost?

4. What elements are behind schedule?
   ahead of schedule?

5. What is the total actual cost of the work performed?

6. What is the total budgeted cost for the work performed?

7. What is the total budgeted cost for the work scheduled?

8. What is the total schedule variance in $?

9. What is the total cost variance?

% COST/SCHEDULE VARIANCE
(Cumulative)

	Dec	Jan	Feb	Mar	April	May
% SCHEDULE VARIANCE	-1.0	-4.9	-9.5	-12.3	-14.9	-11.0
% COST VARIANCE	-4.8	-5.3	-5.0	-5.1	-5.8	-4.9

Use the above information to answer questions 10-12.

10. Is there any relationship between the %cost and %schedule variance? If yes what is it. (such as, as one goes up, the other goes down)

11. What is the trend in the %schedule variance (getting better, worse, staying the same, or no trend)?

12. What is the trend in the %cost variance (getting better, worse, staying the same, or no trend)?

MONTHLY TOTALS

(Cumulative)

	Dec	Jan	Feb	Mar	Apr	May
BCWS	1200	2230	3040	3975	4750	5600
BCWP	1188	2119	2751	3485	4040	4984
ACWP	1245	2232	2889	3662	4273	5229

Use the above information to answer questions 13-14

13. Is there a month(s) that the contractor was under cost (ACWP < BCWP)?

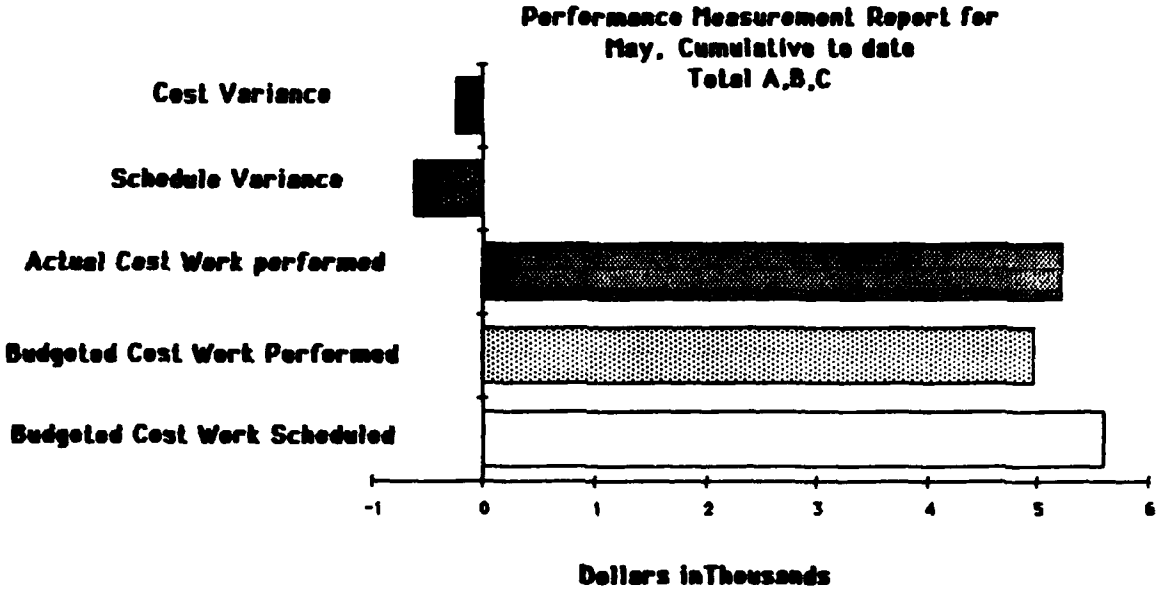
    If yes, which month?

14. Is there a month(s) where the contractor was ahead of schedule (BCWP > BCWS)?

    If yes, which month?

After completing questions 1-14, raise your hand so the time it took you to complete the test can be recorded.

Test One: Graphical



Using the information above answer questions 1-7.

1. Is the contractor behind or ahead of schedule?

2. Is the contractor over or under cost?

3. What is the actual cost of the work performed?

4. What is the budgeted cost for the work performed?

5. What is the budgeted cost for the work scheduled?

6. What is the schedule variance in $?

7. What is the cost variance?

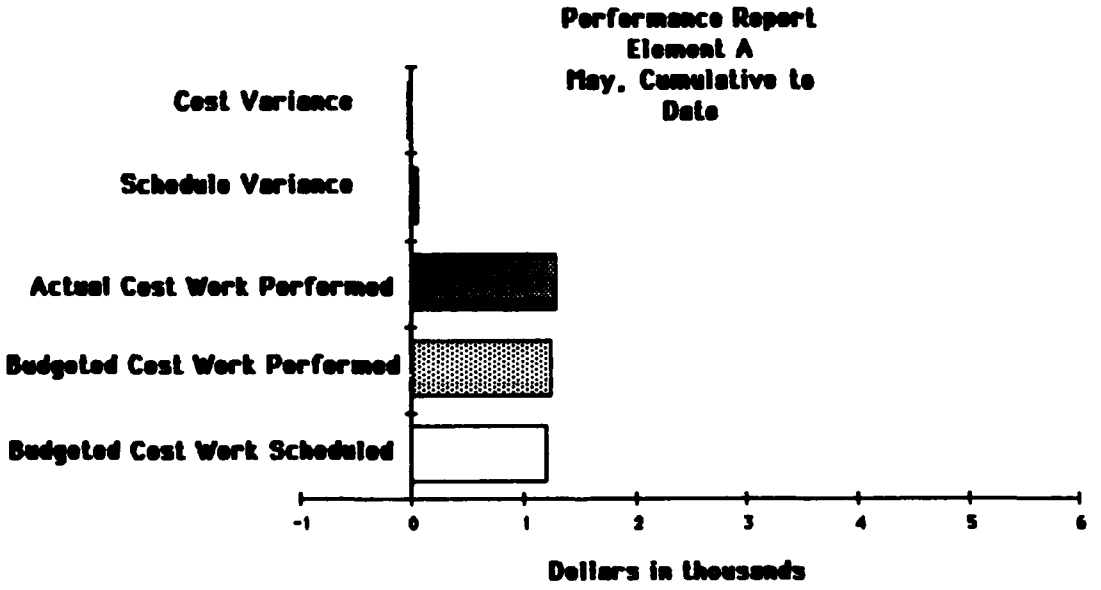
Using the charts on the following page, answer questions 8-9.

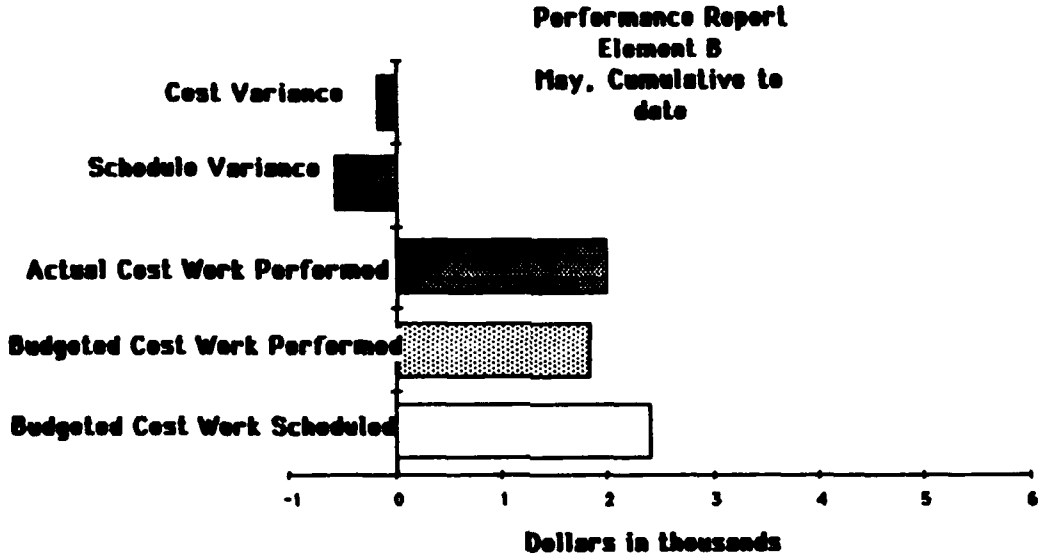
8. What elements are over cost?

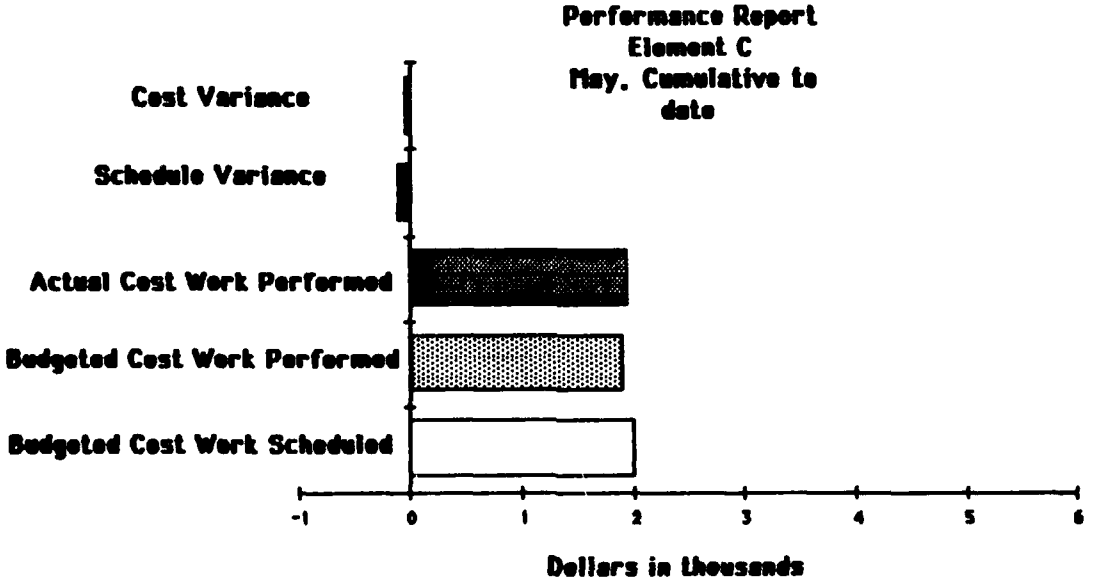
under cost?

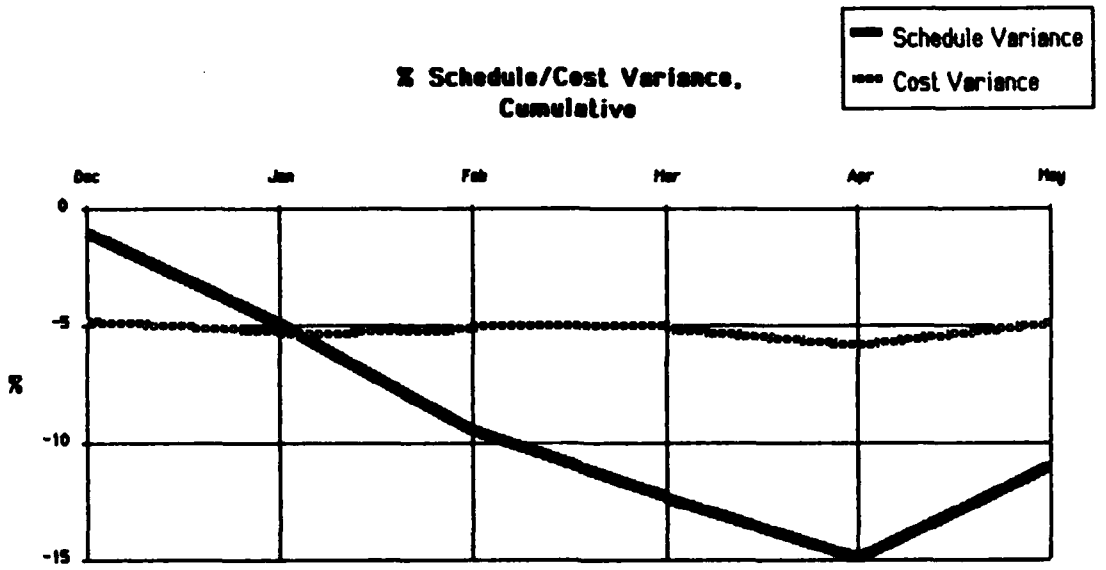
9. What elements are behind schedule?

ahead of schedule?




Performance Report
Element B
May, Cumulative to date
Cost Variance
Schedule Variance
Actual Cost Work Performed
Budgeted Cost Work Performed
Budgeted Cost Work Scheduled
-1
0
1
2
3
4
5
6
Dollars in thousands


Performance Report
Element C
May, Cumulative to date
Cost Variance
Schedule Variance
Actual Cost Work Performed
Budgeted Cost Work Performed
Budgeted Cost Work Scheduled
-1
0
1
2
3
4
5
6
Dollars in thousands

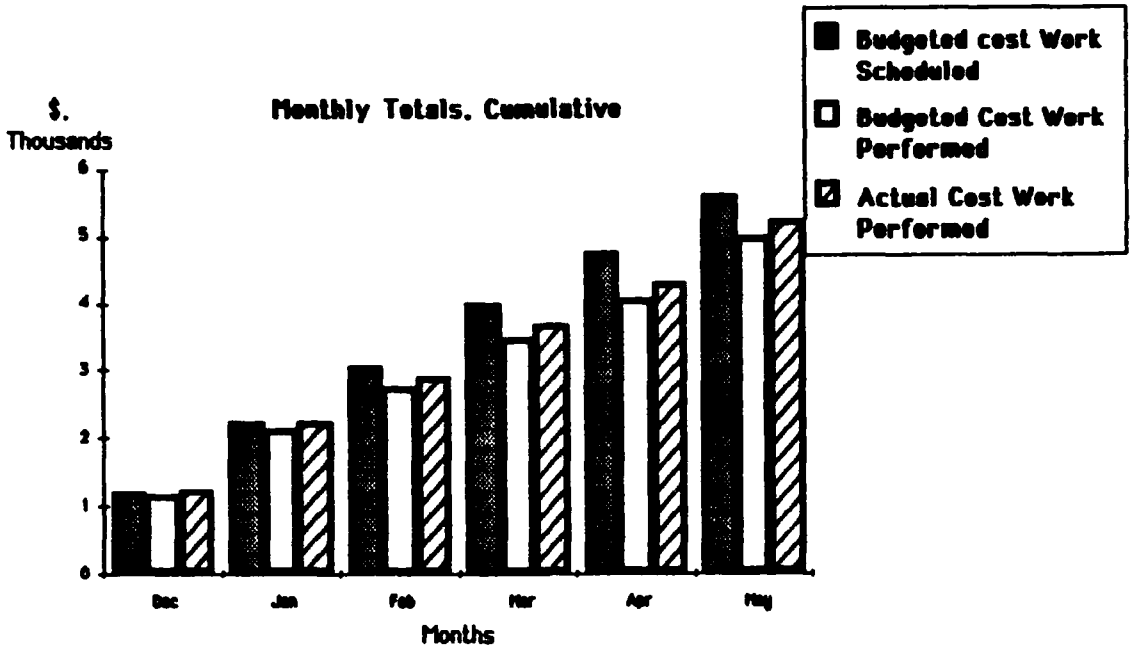


Use the above information to answer questions 10-12.

10. Is there any relationship between the %cost and %schedule variance? If yes, what is it. (such as, as one goes up, the other goes down)

11. Is there any trend in the schedule variance? If yes, what is it? (getting better, staying the same, getting worse, or no trend)

12. Is there any trend in the cost variance? If yes, what is it? (getting better, staying the same, getting worse, or no trend)



Use the above information to answer questions 13-14

13. Are there any month(s) that the contractor was under cost (ACWP< BCWP)?

If yes, which month?

14. Are there any month(s) where the contractor was ahead of schedule (BCWP > BCWS)?

if yes, which month?

After completing questions 1-14, raise your hand, so the time it took you to complete the test can be recorded.

Test Two: Cover Sheet

The Contractor has supplied you with the following information pertaining to project X. Elements A,B, and C make up the project Y. Answer the following questions based on the information supplied. You will have 20 minutes to complete the test.

Key Terms

BCWS - Budgeted Cost Work Scheduled - the amount of work that should have been completed to date and the amount it should have cost.

BCWP - budgeted cost work performed - the amount of work that has been completed to date and the amount that the work should have cost.

ACWP - actual cost work performed - the actual cost of the work that has been completed to date.

BCWP-BCWS = schedule variance

BCWP-ACWP = cost variance

Negative variances implies behind schedule or over cost.

Test Two: Tabular

PERFORMANCE DATA FOR April
(CUMULATIVE TO DATE)

ELEMENT	BCWS	BCWP	ACWP	SCHEDULE VARIANCE	COST VARIANCE
A	2500	2197	2200	(303)	(3)
B	1150	1010	1400	(140)	(390)
C	1700	1493	1688	(207)	(195)
TOTAL	5350	4700	5288	(650)	(588)

Using the information above answer questions 1-9.

1. Is the contractor behind or ahead of schedule?

2. Is the contractor over or under cost?

3. What elements are over cost?
   under cost?

4. What elements are behind schedule?
   ahead of schedule?

5. What is the total actual cost of the work performed?

6. What is the total budgeted cost for the work performed?

7. What is the total budgeted cost for the work scheduled?

8. What is the total schedule variance in $?

9. What is the total cost variance?

% COST/SCHEDULE VARIANCE
(Cumulative)

	Dec	Jan	Feb	Mar	Apr
% SCHEDULE VARIANCE	-35.0	-24.5	-25.8	-14.0	-12.1
% COST VARIANCE	-5.0	-5.5	2.0	-12.0	-12.5

Use the above information to answer questions 10-12.

10. Is there any relationship between the %cost and %schedule variance? If yes, what is it. (such as, as one goes up, the other goes down)

11. Is there any trend in the schedule variance? If yes, what is it? (getting better, staying the same, getting worse, or no trend)

12. Is there any trend in the cost variance? If yes, what is it? (getting better, staying the same, getting worse, or no trend)

MONTHLY TOTALS
(cumulative)

	Dec	Jan	Feb	Mar	Apr
BCWS	1500	2450	3300	4475	5350
BCWP	970	1850	2450	3850	4700
ACWP	1018	1952	2400	4312	5288

Use the above information to answer questions 13-14

13. Are there any month(s) that the contractor was under cost (ACWP< BCWP)?

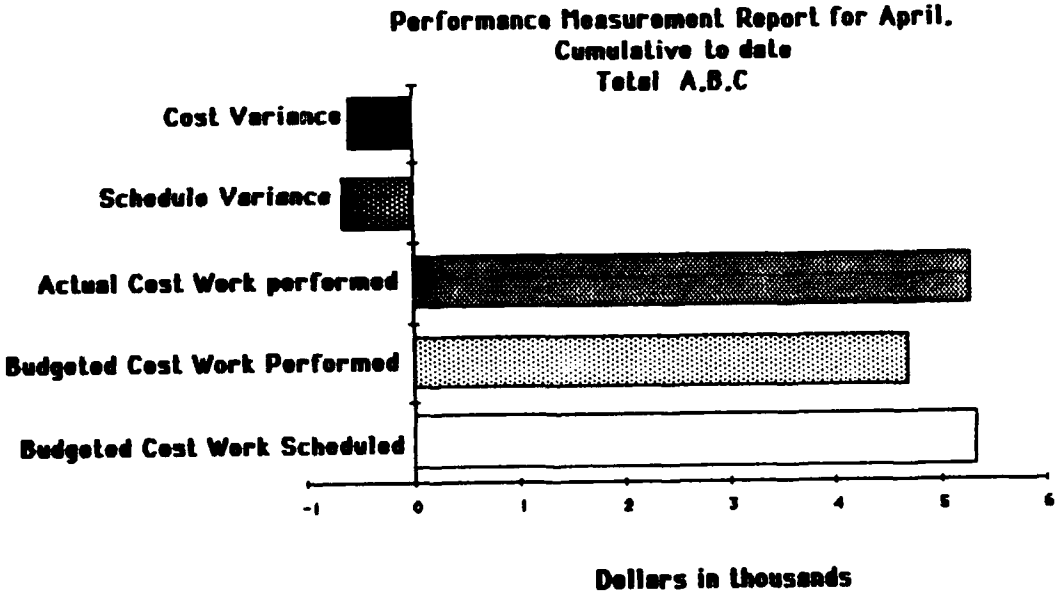
If yes, which month?

14. Are there any month(s) where the contractor was ahead of schedule (BCWP > BCWS)?

if yes, which month?

After completing questions 1-14, raise your hand, so the time it took you to complete the test can be recorded.

Test Two: Graphical



Using the information above answer questions 1-7.

1. Is the contractor behind or ahead of schedule?

2. Is the contractor over or under cost?

3. What is the actual cost of the work performed?

4. What is the budgeted cost for the work performed?

5. What is the budgeted cost for the work scheduled?

6. What is the schedule variance in $?

7. What is the cost variance?

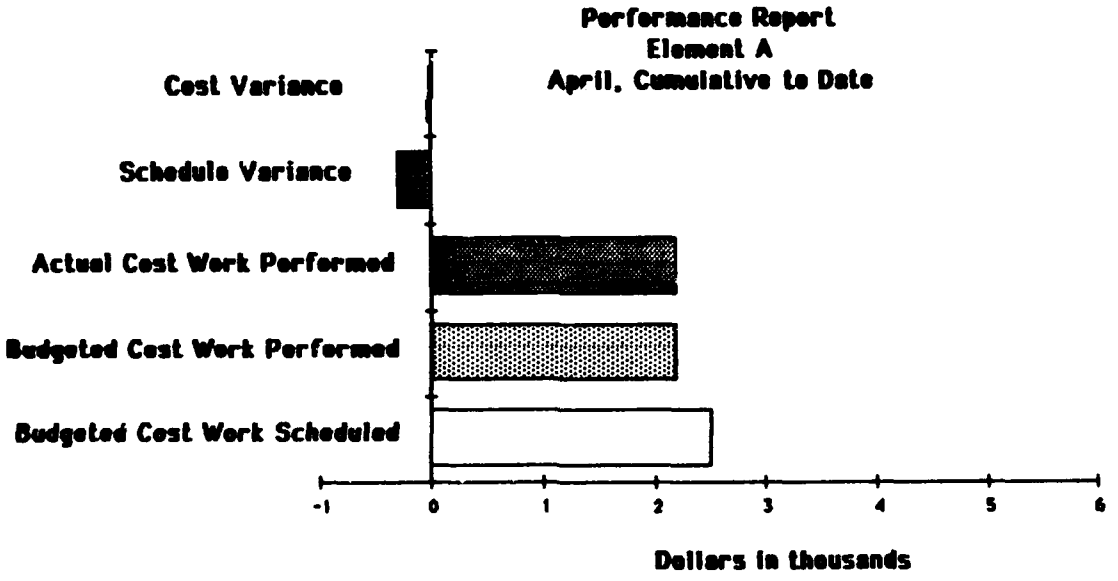
Using the charts on the following page, answer questions 8-9.

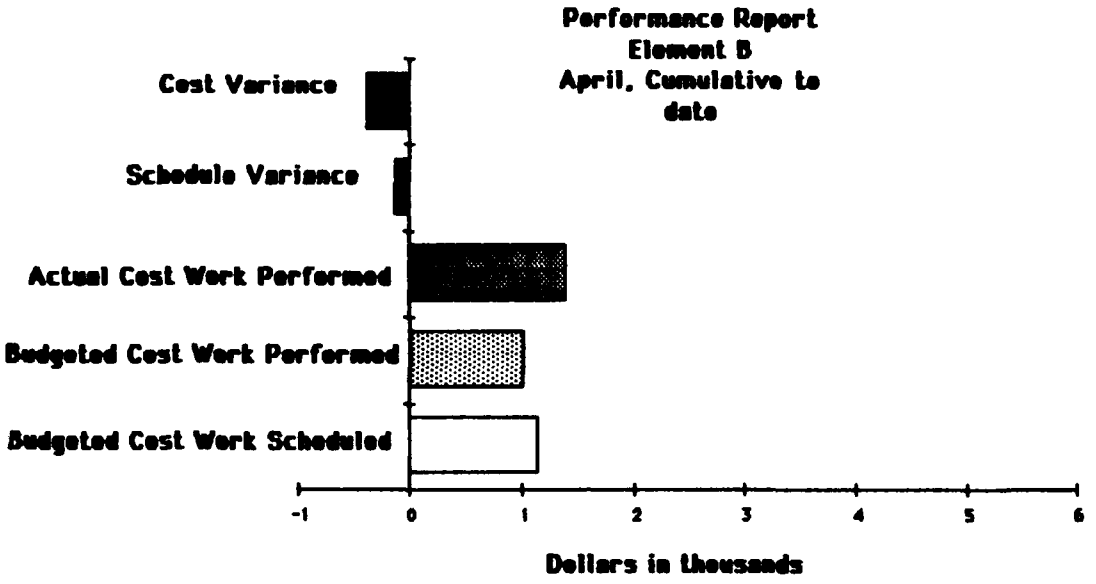
8. What elements are over cost?

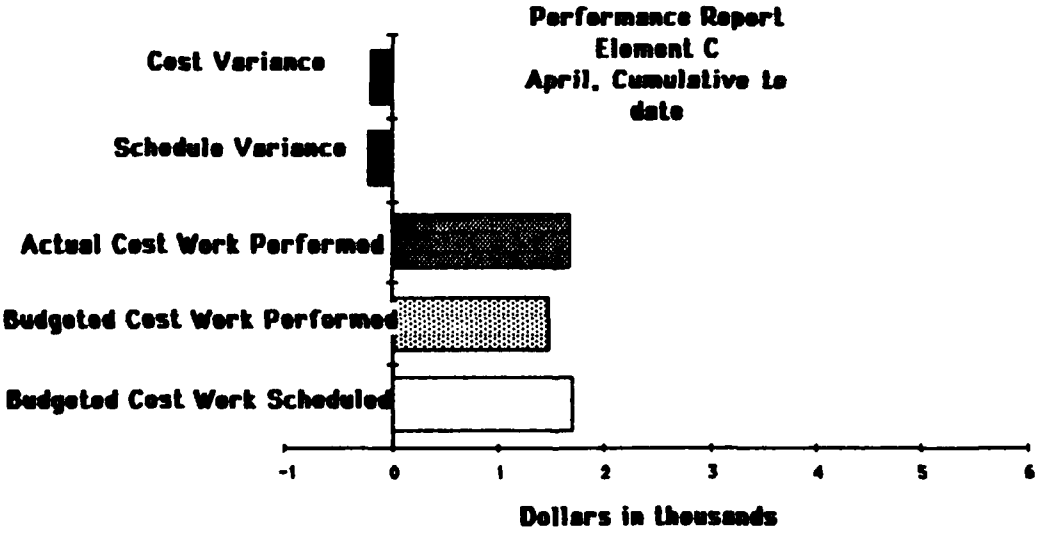
   under cost?

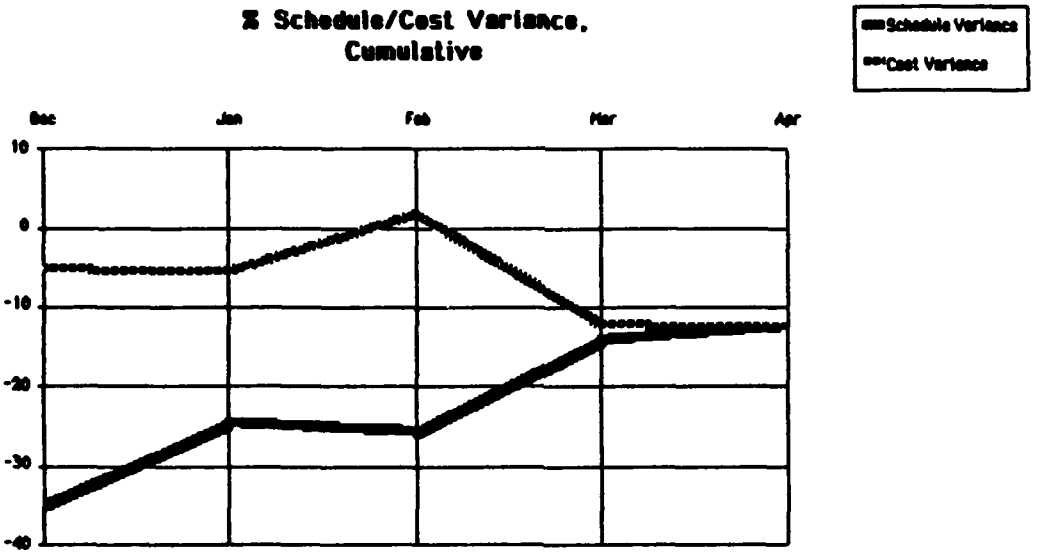
9. What elements are behind schedule?

   ahead of schedule?




Performance Report
Element B
April, Cumulative to date
Cost Variance
Schedule Variance
Actual Cost Work Performed
Budgeted Cost Work Performed
Budgeted Cost Work Scheduled
-1
0
1
2
3
4
5
6
Dollars in thousands


Performance Report
Element C
April, Cumulative to date
Cost Variance
Schedule Variance
Actual Cost Work Performed
Budgeted Cost Work Performed
Budgeted Cost Work Scheduled
-1
0
1
2
3
4
5
6
Dollars in thousands

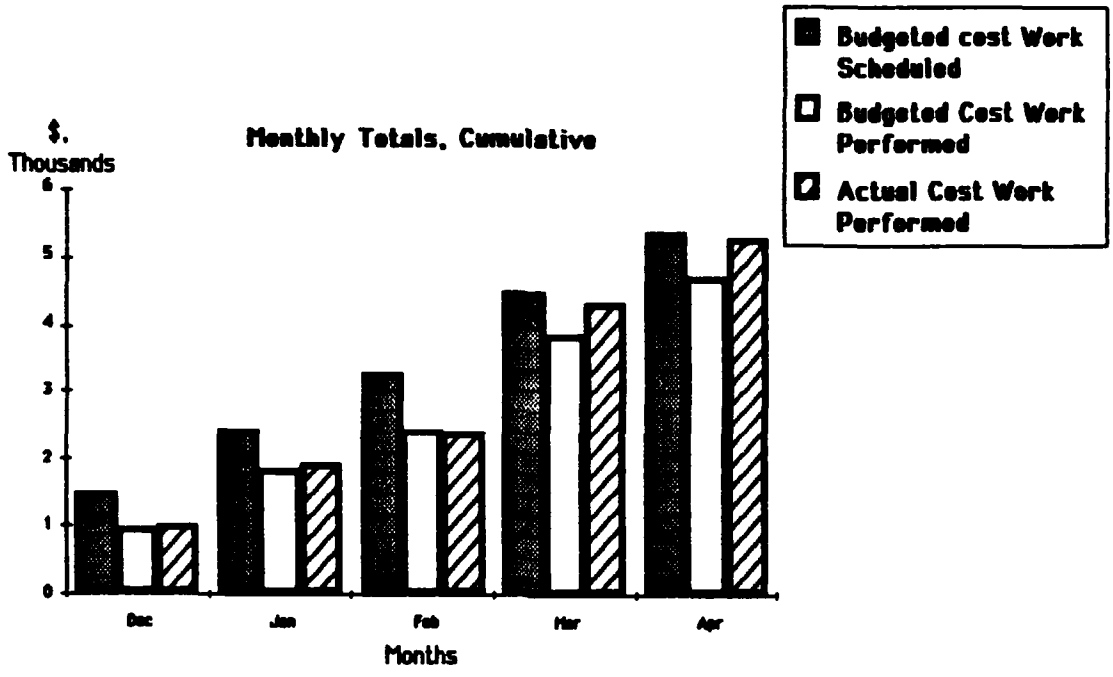


Use the above information to answer questions 10-12.

10. Is there any relationship between the %cost and %schedule variance? If yes, what is it. (such as, as one goes up, the other goes down)

11. Is there any trend in the schedule variance? If yes, what is it? (getting better, staying the same, getting worse, or no trend)

12. Is there any trend in the cost variance? If yes, what is it? (getting better, staying the same, getting worse, or no trend)



Use the above information to answer questions 13-14

13. Are there any month(s) that the contractor was under cost (ACWP< BCWP)?

If yes, which month?

14. Are there any month(s) where the contractor was ahead of schedule (BCWP > BCWS)?

If yes, which month?

After completing questions 1-14, raise your hand, so the time it took you to complete the test can be recorded.

Appendix B: Rating Scales and Demographics Questionnaire

Confidence and Difficulty Rating Scales

Use the following scale and rate the amount of confidence you have in your answers to the above questions.

No Confidence			Moderate Confidence			Extreme Confidence
1	2	3	4	5	6	7

Use the following scale to rate the level of difficulty you had in answering the questions.

Not Difficult			Moderately Difficult			Extremely Difficult
1	2	3	4	5	6	7

Report Rating Scales and Demographics Questionnaire

Rate each report using the following scales

1. How useful was the report format in helping you answer the question?

Graphical

Very useful _____ Not useful

1 2 3 4 5 6 7

Tabular

Very useful _____ Not useful

1 2 3 4 5 6 7

2. How accurate was the report format?

Graphical

Very Accurate _____ Not Accurate

1 2 3 4 5 6 7

Tabular

Very Accurate _____ Not Accurate

1 2 3 4 5 6 7

3. How dificult was the report to understand?

Graphical

Not Difficult _____ Very Difficult

1 2 3 4 5 6 7

Tabular

Not Difficult _____ Very Difficult

1 2 3 4 5 6 7

4. How satisfied were you with the report format?

Graphical

Very Satisfied							Very Dissatisfied
	1	2	3	4	5	6	7

Tabular

Very Satisfied							Very Dissatisfied
	1	2	3	4	5	6	7

5. Which format did you like better? G T

6. Which one would you prefer if you had to do the test again? G T

BACKGROUND INFORMATION

What is your current AFSC (or civilian equivalent)?

How many years of experince do you have in that AFSC?

How long have you been in the AF, or worked for the AF?

Have you used C/SCSC before?
If yes how long?

Have you ever used graphics as a mode of information presentation before?

Grade/Rank_____
Sex_____
Age_____

Bibliography

1. Baumgartner, Stanely J. Systems Management. Washington DC: The Bureau of National Affairs, Inc. 1979.

2. Benbasat, Izak and Albert S. Dexter. "An Investigation of the Effectiveness of Color and Graphical Information Presentation Under Varying Time Constraints," MIS Quarterly:10-83 (March 1986).

3. Benbasat, Izak and Albert S. Dexter. "An Experimental Evaluation of Graphical and Color Enhanced Information Presentation," Management Science, 31:1348-1364 (November,1985).

4. Benbasat, Izak and Ronald N. Taylor. "Behavioral Aspects of Information Processing for for the Design of Management Information Systems," IEEE Transactions on Systems, Man, and Cybernetics, 12:439-45 (July-August 1982).

5. Dammeyer, Rod F. "Developing Information Systems to Meet Management's Needs," Managerial Review, 72:29+ (February 1983).

6. DeSanctis, Geradine. "Computer Graphics as Decision Aids: Directions for Research," Decision Sciences, 15:463-487 (Fall 1984).

7. DeSanctis, Geradine and Sirkka L. Jarvenpaa. "An Investigation of the Tables Versus Graphs' Controversy in a Learning Environment," Proceedings of the 1985 Conference on Information Systems. 134-145. Society of Information Management, Chicago, 1985.

8. Dickson, Gary , Geradine DeSanctis, and D. J. McBride. "Understanding the Effectiveness of Computer Graphics for Decision Support: A Cumulative Experimental Approach," Communications of the ACM, 29:40-47 (January 1986).

9. Ives, Blake. "Graphical User Interfaces for Business Information Systems," MIS Quarterly, 6:15-47 (1982).

10. Keim, Dr. Robert T. and Dr. Ralph Janaro. "Cost/Benefit Analysis of MIS," Journal of Systems Management, 33:20-25 (September 1982).

11. Lusk, Edward J. and Michael Kersnick. "The Effect of Cognitive Style and Report Format on Task Performance: The MIS Design Consequences," Management Sciences, 25:787-798 (August 1979).

12. Orman, Levent. "Information Independent Evaluation of Information Systems," Information and Management, 6:309-316 (December 1983).

13. Porter, Grover L. "The Future of MIS, part 2," Management Accounting, 64:10+ (March 1983).

14. Sage, Andrew P. "Behavioral and Organizational Considerations in the Design of Information Systems and Processing for Planning and Decision Support," IEEE Transactions on Systems, Man, and Cybernetics, 11:640-678 (September 1981).

15. Senn, James A. "Myths VS. Facts About Graphics in Decision Making," Spectrum, 3:1-4 (February 1986).

16. Witkin, H. A., P. K. Oltman, E. Raskin, and S. A. Karp. A Manual for the Embedded Figures Test. Consulting Psychologists Press, Palo Alto (1971).

17. Zmud, Robert W. "Individual Differences and MIS Success: A Review of the Empirical Literature," Management Science, 25:966-979 (October 1979).

18. Zmud, Robert W., Edward Blocher, and Robert Moffie. "The Impact of Color Graphic Report Formats on Decision Performance and Learning," Procedings of the 4th International Conference on Information Systems December 15-17, 1983. 179-193. Society of Information Management, 1983.

VITA

Captain Denise K. Grigware was born on 25 January 1960 at Westover A.F.B. in Massachusettes. She graduated from Steamboat Springs High School in Steamboat Springs, Colorado in 1978. She attended Arizona State University on a four year Air Force ROTC scholarship. She graduated in May 1982 with a Bachelor of Science in Engineering, emphasis in computer science. Upon graduation she was commissioned into the United States Air Force. She entered active duty in June 1982. She was assigned to the 1st Information Systems Group at the Pentagon, where she worked as an OSD Budget System Analyst for three years before coming to the School of Systems and Logistics, Air Force Institute of Technology, in June 1985.

Permanent address: 7709E S. Curtice Way
Littleton, Colorado 80120

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A174 372

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): AFIT/GSM/LSY/86S-8	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: School of Systems and Logistics; 6b. OFFICE SYMBOL (If applicable): AFIT/LSY	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code): Air Force Institute of Technology, Wright-Patterson AFB, Ohio 45433-6583	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS. — PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.
11. TITLE (Include Security Classification): See Box 19	
12. PERSONAL AUTHOR(S): Denise K. Grigware, Capt, USAF	
13a. TYPE OF REPORT: MS Thesis; 13b. TIME COVERED: FROM _____ TO _____; 14. DATE OF REPORT (Yr., Mo., Day): 1986 September; 15. PAGE COUNT: 93	
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES		
FIELD	GROUP	SUB. GR.
09	04	

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number): Information Systems, Information Presentation, Management Information Systems, Computer Graphics

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Title: AN INVESTIGATION INTO THE EFFECT OF THE MODE OF PRESENTATION ON CONTRACT EVALUATION WHEN COST/SCHEDULE CONTROL SYSTEM CRITERIA IS USED

Thesis Chairman: Thomas Triscari, Jr., Captain, USAF
Assistant Professor of Systems Management

Approved for public release: IAW AFR 190-1.

LYNN E. WOLAVER 29 Sep 86

Dean for Research and Professional Development

Air Force Institute of Technology (AU)

Wright-Patterson AFB OH 45433

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL: Thomas Triscari, Jr., Captain, USAF	22b. TELEPHONE NUMBER (Include Area Code): 513-255-3355; 22c. OFFICE SYMBOL: AFIT/LSY

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

This research focused on which mode of presentation, tabular or graphical would be more effective in aiding a program manager in his evaluation of a contractor's performance when cost/schedule control systems criteria is used. Effectiveness was measured in terms of decision quality, speed, confidence, and difficulty. A review of the literature in this area identified several important variables that might effect an individual's performance when a particular mode of presentation is used. These variables include the task to be accomplished, field independence/dependence, and experience.

Two test scenarios were designed to test the individual's ability to detect trends, come up with precise numbers, and evaluate a contractor's performance using graphical or tabular information. The scenarios were administered to individuals who are or will be involved in the acquisition process. Along with the test scenarios, the Group Embedded Figures Test was administered to the subjects to determine if the individual was field independent or dependent. A questionnaire was also developed to collect background information on the sample population.

A statistical analysis of the data collected indicated that the task to be accomplished had a large effect on which mode of presentation was most effective. Tabular information was best when accuracy was desired, and graphical data was best when trends needed to be analyzed.

END

12-86

DTIC